Symbols and Constants

F	force
Q	charge
$\vec{E}$	electric field
$\vec{D}$	displacement field
$\vec{P}$	polarization field
$\vec{H}$	magnetic field
$\vec{B}$	magnetic flux density field
$\vec{M}$	magnetization

V	
$\vec{A}$	
ρ	
I	current
$\vec{j}$	current density
ε_R	relative permittivity
μ_R	relative permeability

$\varepsilon_0 \approx 8.85 \times 10^{-12}$ F/m

$\mu_0 = 4\pi \times 10^{-7}$ N/A^2

Vector Calculus

cross products

Cartesian	$\vec{a}_x \times \vec{a}_y = \vec{a}_z$	$\vec{a}_y \times \vec{a}_z = \vec{a}_x$	$\vec{a}_z \times \vec{a}_x = \vec{a}_y$
cylindrical	$\vec{a}_\rho \times \vec{a}_\phi = \vec{a}_z$	$\vec{a}_\phi \times \vec{a}_z = \vec{a}_\rho$	$\vec{a}_z \times \vec{a}_\rho = \vec{a}_\phi$
spherical	$\vec{a}_r \times \vec{a}_\theta = \vec{a}_\phi$	$\vec{a}_\theta \times \vec{a}_\phi = \vec{a}_r$	$\vec{a}_\phi \times \vec{a}_r = \vec{a}_\theta$

Electrostatics

Coulomb's law
$$\vec{F}_2 = \frac{Q_1 Q_2}{4\pi\varepsilon_0 R^2}\vec{a}_{12}$$

$\vec{E}$ of point charge
$$\vec{E} = \frac{Q\vec{a}_r}{4\pi\varepsilon_0 r^2}$$

$\vec{E}$ of charge distribution
$$\vec{E} = \int_V \frac{\rho(\vec{r}\,')\,dV'}{4\pi\varepsilon_0 |\vec{r}-\vec{r}\,'|^2}\frac{\vec{r}-\vec{r}\,'}{|\vec{r}-\vec{r}\,'|}$$

Gauss's law
$$\varepsilon_0 \oint_S \vec{E}\cdot d\vec{S} = Q_{\text{enclosed}}^{\text{total}} = \int_V \rho\, dV$$
$$\oint_S \vec{D}\cdot d\vec{S} = Q_{\text{enclosed}}^{\text{free}} = \int_V \rho_{\text{free}}\, dV$$
$$\oint_S \vec{P}\cdot d\vec{S} = -Q_{\text{enclosed}}^{\text{bound}} = -\int_V \rho_{\text{bound}}\, dV$$

relating $\vec{E}$ to V
$$\vec{E} = -\vec{\nabla} V$$

relating V to $\vec{E}$
$$V_{AB} = -\int_B^A \vec{E}\cdot d\vec{l}$$

V of charge distribution	$V = \int_V \frac{\rho(\vec{r}\,')\,dV'}{4\pi\varepsilon_0 \lvert \vec{r} - \vec{r}\,' \rvert}$
capacitance	$C = Q/V$
parallel plate capacitor	$C = \frac{\varepsilon_0 \varepsilon_R A}{d}$ of dimensions A and d
Poisson's equation	$\nabla^2 V = -\rho / \varepsilon_0 \varepsilon_R$
Laplace's equation	$\nabla^2 V = 0$
linear dielectrics	$\vec{D} = \varepsilon_0 \varepsilon_R \vec{E}$
boundary conditions	E_T and D_N continuous
energy	$W = \frac{1}{2} \int_V \vec{E} \cdot \vec{D}\, dV$

Magnetostatics

law of Biot-Savart	$\vec{H} = \oint \frac{I\, d\vec{l} \times \vec{a}_R}{4\pi R^2}$
law of Biot-Savart	$\vec{H} = \int_V \frac{\vec{j} \times \vec{a}_R\, dV}{4\pi R^2}$
Ampere's law	$\oint \vec{H} \cdot d\vec{l} = I_{\text{enclosed}}$
inductance	$L = N\phi / I$
vector potential	$\vec{A} = \int_V \frac{\mu_0 \vec{j}\, dV}{4\pi R}$
relating $\vec{B}$ to $\vec{A}$	$\vec{B} = \vec{\nabla} \times \vec{A}$
linear materials	$\vec{B} = \mu_0 \mu_R \vec{H}$
boundary conditions	H_T and B_N continuous
energy	$W = \frac{1}{2} \int_V \vec{B} \cdot \vec{H}\, dV$

Electromagnetics

Maxwell's equations	$\vec{\nabla} \cdot \vec{D} = \rho$	$\vec{\nabla} \cdot \vec{B} = 0$
	$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$	$\vec{\nabla} \times \vec{H} = \vec{j} + \frac{\partial \vec{D}}{\partial t}$